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SEVENTH INTERNATIONAL CONFERENCE ON WEIGHTS AND MEASURES

A remarkable advance toward complete international agreement on fundamental questions of measurement took place at the Seventh International Conference on Weights and Measures, held last September in Paris. At this conference the United States was represented by the Director of the Bureau of Standards. The present year is the fiftieth anniversary of the establishment of the International Bureau of Weights and Measures, and in commemoration of the event a special meeting was held under the auspices of the French Academy of Sciences in connection with the conference. A history of the International Bureau by its director, Dr. Ch.-Éd. Guillaume, was published and gives an interesting review of past achievements.

The conference just held was the most important in point of results secured since the first conference in 1875. The actions taken affect fundamentally many kinds of measurements and standards and are based on the results of painstaking scientific research, covering many years. The new decisions involve the international temperature scale, the fundamental standard of length of the world, and the basis of the world's electrical units.

Under the treaty of May 20, 1875, there was established the International Committee on Weights and Measures, the International Bureau of Weights and Measures, and the International Conference on Weights and Measures. The treaty, to which 31 of the leading governments are now parties, gives the conference jurisdiction

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over the fundamental problems affecting the international metric standards and precise metrology. The royal grounds and residence at Sèvres set aside by the French Government were made internationally neutral territory to be devoted to the International Bureau of Weights and Measures, where the international standards were to be deposited and the precise comparisons of national standards executed from time to time. Here were made the final standards of the meter and kilogram, and here these standards were intercompared for distribution to the various governments of the world. This historic center is now replete with records of achievements in the science and art of measurement during the past half century.

The international conference meets once in six years and is made up of delegates from the 31 national governments. Adoption of any proposition by the conference can only be secured by the unanimous vote of all nations represented, each nation having one vote. The recommendations of the conference are (in effect and when ratified) binding on the signatory powers, and because of this fact and because unanimous agreement is required for adoption the process of effecting important changes is usually slow.

Immediately before the conference just held the Director of the Bureau of Standards met with the representatives of the national laboratories of Great Britain and Germany, and in an informal conference these three nations agreed on every value for the international temperature scale. These values were accepted by the international conference, with the understanding that a special international committee would be chosen to study the matter of temperature measurements and recommend such revisions as may be found necessary from time to time in the future.

The significance of the final adoption of the international temperature scale by 31 nations is a matter of such great interest to science and industry that a brief summary of what this involves should be given. The action assures the following desirable ends:

1. A uniform basis for expressing all quantities involving temperature and heat measurement, such as tables of properties of refrigerants, steam tables, heats of combustion, specific and latent heat of materials, and particularly fixed temperatures, such as freezing, boiling, and transition temperatures of substances.

2. A uniform basis for calibration of all temperature-measuring instruments particularly those for export from one nation to another. This is particularly important in the case of pyrometers for use at very high temperatures.

3. A common basis in all countries for the certification of precision temperature-measuring instruments for use in all precise experimental or research work involving temperature measurements. Such basis is now so well defined and universally understood as to make it unnecessary for the researcher in publishing his results either to establish or define his own temperature scale as has often been necessary in the past.

4. While for a number of years the three national laboratories of England, Germany, and the United States have been in substantial agreement in the certification of temperature-measuring instruments, the adoption of their recommendations by the international bureau will have the effect of bringing all the important countries of the world together in the matter of temperature measurements, and will stabilize the basis of temperature measurement and eliminate differences in details. The desire to eliminate such differences has already led the laboratories to make intercomparisons of calibrated instruments in preparation for the formal adoption of the scale, and this interchange will lead to the establishment of closer and more cordial relations.

5. It is also significant that each of the laboratories has been willing to modify its position where necessary, since it was apparent to all that international agreement was of much greater

importance than precise adherence to the practice of the individual laboratories.

The proposition of the United States to define the length of the international meter in terms of the wave length of the red radiation from the cadmium lamp was also tentatively adopted, the final wording of the recommendation as decided upon by the conference being an improvement on that submitted by the United States. As a result of this action, there is now established a permanent natural standard of length, easily reproduced, and capable of being used in the most precise measurements we are ever called upon to make. Although the particular line chosen in the spectrum of cadmium is believed to be a very good one for this purpose, the way has been left open to utilize a better line, such as one of those in the spectrum of Krypton, if future investigations prove this to be desirable.

The conference tentatively adopted the value determined by Fabry and Perot in 1906 as expressing the relation between the international meter and the wave length of red light from cadmium vapor. This relation is

1 meter = 1,553,164.13 waves

under certain definitely stated standard conditions.

The wave length of cadmium light is thus accepted as a standard in terms of which lengths may be measured and other light wave standards may be expressed. This action is of great importance because of the fact that many precise length measurements in science and industry are now made in terms of light waves, and is particularly useful for setting up and intercomparison of gauge blocks and other subdivisions of the meter.

It was also the hope of the United States delegates that the conference would adopt or recommend a definite relation between the yard and the wave length of light, or between the yard and the meter. The adoption of such a relation is equally important, since it would overcome a difficulty which often arises; that is, of converting wave lengths to inches, a different relation being used in this country and in Great Britain.

This agreement on the length of the British and American yards, which now differ by a few millionths of an inch, unfortunately was not brought about. Research is now in progress in England on the length of their national standard, and pending the completion of this work it appeared impossible to reach an understanding. The difference is very small, but is becoming of importance in making some of the finer measuring tools now used by industry. It was held by the conference, however, that the relation between the yard and the meter, or between the yard and the wave length of light, was a matter that should be settled by the United States and Great Britain rather than by the international conference, and no action was therefore taken. However, the British delegates expressed themselves as heartily in favor of the idea, and agreement between the systems of the two countries will undoubtedly be brought about in time.

The matter of standard temperatures at which end standards (gauge blocks) shall be certified was also considered in connection with length measurements. It is desirable to employ a temperature or temperatures at which the blocks are actually used. At present, there are many variations in the practice of different nations. A committee will be chosen to consider the question and, if possible, agree upon not more than two standard temperatures at which end standards will be certified.

The third major problem considered by the conference was the standardization of the electrical units and the scope of the international bureau in relation to electrical measurements.

Up to the present time international agreements with regard to electrical measurements have been made by electrical congresses and international committees formed for this specific purpose. The number of international organizations has, however, multiplied so greatly that it has become desirable to combine them and reduce the number of special

organizations. In accordance with this general principle the international conference has been authorized to establish electrical units.

The United States is concerned with maintenance of international uniformity in electrical measurements for two practical reasons. One is the need for uniformity in manufacture and rating of electrical machinery and appliances, and the other the international use of the results of scientific research. In order to bring about such uniformity, agreement was reached many years ago on certain electrical units which were called "international" to distinguish them from the "absolute" values which might be found more or less different from the accepted units as methods of measurement were perfected. In fact, such a difference has been found in the case of the ohm, and we now know that the international ohm is one-twentieth of 1 per cent too large. While such a difference is of no great practical importance at the present time, the demands of industry for precise measurements are growing rapidly, and such a difference may become important in the future. The international committee must, therefore, decide whether to maintain the old value of the ohm or to adjust it to accord with mechanical measurements as originally intended.

When the international units were adopted certain kinds of concrete standards were also accepted as a means of maintaining the values of the unit. These are a column of mercury of specified dimensions for the ohm, and a voltameter in which the amount of silver deposited in a given time by a current is used as a measure of the ampere. The international committee must decide whether to retain these old standards or to substitute new methods of establishing the units which have been developed in the several national laboratories.

In order to advise it as to the best solution for these questions, the international committee is establishing a special technical commission of 10 members, including representatives appointed by the several national laboratories, and is to report by March, 1929.

For several years the Bureau of Standards has been putting as much attention as it could on these fundamental electrical problems and has already made some redeterminations of the true value of the ohm and the ampere by absolute methods. In order to be of value the results of such work must be certain to within a few parts in 100,000, and, therefore, many precautions must be taken which are entirely unnecessary in any ordinary measurements. The work is therefore very time consuming, and still more intensive effort must be put upon it in order to have results available by the spring of 1929.

COOPERATIVE MEASUREMENTS OF RADIO FADING IN 1925

At the beginning of 1925 the bureau invited a number of laboratories to participate in a cooperating program of radio measurements. This work, which was continued for a year, was largely confined to measurements of fading at frequencies within the broadcast band. The general plan of the work was the arrangement of special transmissions in which a station transmitted continuously during a specified period while the observing laboratories made graphic records simultaneously, employing the method previously used by G. W. Pickard.

The investigation included observations during the solar eclipse of January 24, during many sunset periods, and during a complete 24-hour cycle, in addition to a special study of the effect of high power on fading. The analysis of more than 150 graphic records made by 23 cooperating laboratories located in northeastern United States and Canada established a number of new facts about fading and radio-wave transmission.

Among the principal conclusions resulting from the research are the following:

1. There is a degree of regularity in the average intensity during conditions of fading which has not hitherto been

suspected. The ratio of average night to day intensity has a logarithmic relation to distance.

2. There are indications of series of maxima and minima of fluctuation with respect to distance from the transmitting station. The first maxima occurs at about 100 km.

3. There is some evidence of correlation between direction shifts and fast fading.

4. The maximum diurnal intensity appears at about the same time (during the three hours just preceding sunrise, in December) at all receiving points within 500 km of the transmitting station (this conclusion is based on a single 24-hour observation period).

5. There is sometimes a special periodic type of fading, beginning about 15 to 20 minutes after sunset, of great regularity, the periodicity of which shows a correlation with the distance between the transmitting and receiving points, and which is evidently due to an interference phenomenon.

6. Changes of transmitting power do not affect the characteristics of fading.

A more complete description of the method and results of this investigation have just been published in Scientific Paper No. 561, Cooperative Measurements of Radio Fading in 1925, by J. H. Dellinger, C. B. Joliffe, and T. Parkinson. This paper can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 15 cents per copy.

PROGRESS REPORT ON MECHANISM OF COLOR SENSITIZATION AND HYPERSENSITIZATION

The work discussed here is part of a more comprehensive program of research on the mechanism of sensitization by dyes for new spectral regions. It is based on observation of three factors, which we may predict, from well-known principles of colloid chemistry, to be of importance. These are, as usual, by no means completely independent, but they may logically be taken up as distinct topics.

The sensitivity to white light (total sensitivity) was measured by the standard methods, using an incandescent light corrected by Corning glass to give a color match with Priest's artificial sunlight. The sensitivity conferred by the dye was judged from a sensitometer test in which a Wratten "Minus Blue" filter was inserted between the light source and plates, in addition to the correction filter. The "Minus Blue" filter "cuts" very sharply at approximately 500 millimicrons; the speed of these emulsions without dye is almost zero through this filter, while practically all the radiation for which any of the dyes (except pinaflavol) sensitize, is freely transmitted. For brevity, the speed measured in this way will be called "M. B." speed. It is $10/i$, where i is measured in candle-meter-seconds of sunlight quality incident on the minus blue filter. An interesting feature of all the data is the higher gamma for the exposures behind the minus blue filter; the effect has been known in practical three-color work for some time, but only recently confirmed quantitatively, and the magnitude is rather striking, ranging from 15 to 50 per cent.

The dyes used in sensitizing are closely restricted in type and limited in number, but of the two types in common use, one is acid and the other basic.

The acid type is the eosins, halogen substitution products of fluorescein, and of these only one is believed to be in regular use; this is erythrosin, tetraiodofluorescein, and practically all orthochromatic emulsions are sensitized with this dye, while it is the green sensitizer of most panchromatic emulsions. It is regularly used as the sodium salt, which is soluble in water to the extent of more than 2 grams per liter, and may be assumed to ionize to the positive sodium and negative dye ions; the concentration of dye ion should be reduced by increasing hydrogen ion concentration (decreasing pH), since the dye acid is very weak and very slightly soluble. According to the present theories, the negative dye ion would be adsorbed

at a silver ion of the silver bromide crystal lattice.

The basic dyes are extremely complex quarternary nitrogen bases, derived from quinoline or pyridine; there are several subgroups, such as isocyanines, carbocyanines, etc. These dyes are the halogen salts of nitrogen bases; they are slightly soluble in alcohol, pyridine, and some other organic solvents, but almost insoluble in water, in which they form colloidal suspensions. The trace which is in true solution in water should ionize into negative halogen, and positive dye ions; the dye ion would be adsorbed at a bromide ion of a silver bromide crystal. Increasing hydrogen ion concentration would not affect the ionization, but converts the dyes, at varying pH's depending on the dye, into colorless forms which naturally do not sensitize; the color and sensitizing properties return with return of the reaction to neutrality, if the acid treatment has not been too severe. Traces of soluble halide would, on the other hand, strongly repress the dissociation, since the concentration of halide ion in equilibrium with the solution of the pure dye is almost infinitesimal, although real. These dyes are very possibly adsorbed best from colloidal suspension rather than from true solution, since the resulting sensitization from a given bath rapidly decreases as water is replaced by alcohol or pyridine in the solvent mixture. It has recently been determined that the adsorption of orthrochrome T (one of the isocyanines) decreases with decreasing pH.

I. Mutual effect of the dye and after-ripening.—Ripening of the emulsion after washing must consist almost entirely in the formation of nuclei on the surface of the grains, since in the absence of solvents such as ammonia or soluble bromide, the recrystallization is entirely negligible. The presence of dye adsorbed to the surface would, therefore, be expected to influence the after-ripening. We had previously observed a retardation of storage ripening (in the dried plates). The experiments were extended to include digestion of the emulsion in the washed state before coating. Experiments were made both with neutral and ammoniacal emulsions; both deteriorated seriously in five months, either from the use of a new make of gelatin or from unfavorable conditions of storage; and with the ammonia emulsions, this goes so far as to interfere with judgment of the results in some cases. The after-ripening and deterioration through fog, while not independent, are not necessarily affected in the same way by the dye.

On the basis of the results available to date, the after-ripening judged by change in white-light speed, is retarded but not stopped by pinacyanol or pinaverdol; this applies either to digestion or storage ripening. The "M. B." speed with pinacyanol is approximately constant, during after-ripening which may amount to 100 per cent on white-light sensitivity. A pinaverdol-sensitized batch gave a distinct increase in "M. B." speed, but the filter factor increased on storage. Erythrosin (one case) did not appear to retard the after-ripening at all, and the filter factor actually decreased during storage. It is quite possible that the erythrosin will be found fundamentally different from the basic dyes in this respect. It is also practically free from the tendency to cause fog, which is one of the serious difficulties in using the basic dyes. We found (in two cases, with pinacyanol) that a batch of emulsion first digested, then sensitized, fogged less on storage than other batches of the same emulsion which were, respectively, digested with the dye, and sensitized without digestion. In other words, there was more fog when all the after-ripening occurred in the presence of the dye, than when most of it took place first, as would be expected; and furthermore the dye is to some extent a protection against storage fog.

Six emulsions, each subdivided into from 4 to 11 batches, still remain to be tested for keeping qualities.

II. Effect of pH on color sensitivity.—The sensitivity of any silver bromide-

gelatin emulsion, with or without dye, increases with increasing pH during digestion and at coating. Superimposed on this is a change in the relative color sensitivity (filter factor), the contribution by the dye increasing faster than the total sensitivity. It is still open to question whether ammonia hypersensitization is not merely a matter of increasing pH, although a specific action of nitrogen bases, such as ammonia, is probable. Erythrosin becomes less ionized and less soluble in solutions of increasing hydrogen ion concentration (decreasing pH), while pinacyanol should be less affected. If the ion, rather than the molecule, of the dye is adsorbed, erythrosin should then be the more affected by changing pH, and we actually find that this is the case. The relative color sensitivity of erythrosin-sensitized batches of a given emulsion decreases more rapidly with decreasing pH than does that of the pinacyanol-sensitized batches.

III. Effect of soluble bromide on color sensitivity.—The marked reduction in color sensitivity produced by traces of soluble bromide is most probably caused by selective adsorption of the bromide instead of the dye. The dyes are complex compounds of high molecular weight (300 to 700) and are used in very small amounts, so that traces of soluble bromide added as preservatives are likely to be much the larger when expressed in terms of chemical equivalents. For example, taking approximately optimum conditions, a liter of emulsion is sensitized with 5×10^{-6} mol. of pinacyanol or 2×10^{-5} mol. of erythrosin. The addition of 5 ml of N/100 soluble bromide, or 5×10^{-4} mol. is necessary to produce any marked improvement in the stability, and this increases the filter factor by an average of 50 per cent in the erythrosin-sensitized emulsions. The results with pinacyanol were less consistent, but it appears to be less sensitive to bromide than the erythrosin. The effect on the erythrosin would be predicted from the fact that both bromide and erythrosin ions are adsorbed to the silver ions of the silver bromide lattice. The effect on the basic dyes is most readily explained by the decrease in their true solubility on addition of soluble bromide; this has recently been proved by experiment.

We propose to cover the following additional points in continuing the investigation:

A. Further study of the effect of pH on sensitivity, including:

1. Comparison of hypersensitization by solutions of given pH of ammonia, pyridine, and other nitrogen bases on the one hand, and nitrogen-free bases such as borax and sodium carbonate on the other.

2. Comparison of the relation between pH and sensitivity for pinacyanol and for dyes such as kryptocyanine which are decolorized at higher values of pH.

B. Effect of the ratios of soluble bromide to dye, as well as the ratio of soluble bromide to silver bromide. (The grain size, or rather specific surface of the silver bromide, will have to be considered in this connection.)

C. The possible hypersensitizing action of silver bromide solvents, such as potassium cyanide, which act in such low concentrations that they do not coagulate dyes; the possibility here being that dye would be adsorbed better at a freshly etched surface.

FLUORESCENCE AS A MEANS OF DETECTING THE ADMIXTURE OF REFINED IN UNREFINED EDIBLE OLIVE OIL

Unrefined (particularly natural or virgin) olive oil is considered superior to refined olive oil, and has thus a higher commercial value. Some visitors recently brought to the bureau samples of olive oil alleged to be 100 per cent natural, 100 per cent refined, and various mixtures of natural and refined, as well as various other samples, some labeled as virgin, all of European origin. The difference in color between the alleged 100 per cent natural oil and the 100 per cent refined oil was not great,

chemical tests for differentiating the two were said to be inadequate, and it is apparently difficult even for an expert taster to be certain of his conclusions. As a result, it is claimed that much of the imported olive oil labeled as virgin oil is in reality adulterated with a considerable proportion of refined oil.

However, information had been obtained that an instrument was now being used in France by means of which small admixtures of refined olive oil in unrefined oil could be detected. It was said that this instrument made use of the "365 ray." Acting on this information, the oils submitted were examined with ultra-violet energy, using a quartz-mercury lamp and Corning ultra-violet filters. The resulting fluorescence was quite striking. The alleged 100 per cent natural oil showed a yellowish fluorescence, very similar to the color of the oil by daylight, the alleged 100 per cent refined oil showed a bluish fluorescence, and mixtures of natural and refined showed intermediate colors. All of the samples of European origin so far examined show a fluorescence which may be placed (at least approximately) somewhere in the color sequence between the alleged 100 per cent natural and 100 per cent refined oils.

On the other hand, a sample of California pure unrefined olive oil obtained from the Bureau of Chemistry, said to be of high chlorophyl content, showed a much redder fluorescence than the European oils; and a sample of this same oil refined in the Bureau of Chemistry laboratories showed but little indication of the bluish fluorescence. The question may, therefore, be raised as to the general applicability of this method of examination.

Since these experiments were made it has been learned from L. J. Buttolph, of the Cooper Hewitt Electric Co., that similar tests have recently been made by others using their mercury lamps. Beyond this, there seems to be very little knowledge of this matter in America. Inquiry of a number of leading chemists in the vegetable-oil industry has failed to elicit any information concerning it. So far as the bureau knows, the observations concerning the difference between the behavior of European and California oils in this test are new. Further investigation will be necessary to decide whether or not this test may be relied upon in all cases to distinguish certainly between unrefined and refined oil; but it may be said that the test is very simple and convenient, and the results have been very striking for the samples submitted.

An account of the experiments made by K. S. Gibson at the Bureau of Standards was communicated (orally by I. G. Priest) to the meeting of the American Oil Chemists' Society in New York, October 28, 1927.

CARBOHYDRATES TO BE STUDIED BY NATIONAL RESEARCH COUNCIL FELLOWSHIP

Dr. W. C. Austin has recently been appointed a research associate in the sugar section of the Bureau of Standards, having been granted a fellowship by the Medical Fellowship Board of the National Research Council. His subject will be "Carbohydrates." The question of metabolism and carbohydrate structure is deemed an important subject for investigation, as but little information is available on that important relation which exists between the structure of the sugars and the human physiology and metabolism. This borderland is a most difficult field in which to carry out experimental investigation and requires investigators with a knowledge of both the subjects of metabolism and carbohydrate structure.

CHANGES IN DRY CLEANING RESEARCH ASSOCIATESHIP

The bureau is particularly interested in the establishment of the National Association Institute for Dyeing and Cleaning at Silver Springs, Md., a suburb of Washington. The director of the institute, C. C. Hubbard, and his assistants, Messrs. Goldman and Heckethorne, have been stationed at the bureau as research associates for some time, and many of

the plans for the institute grew out of the research work done in that connection.

The association plans to continue the research work which has been started on projects in connection with the dyeing and cleaning industry both in their own laboratories and at the Bureau of Standards. A. S. Eichlin, formerly a textile chemist on the bureau's staff, has been engaged as a research associate for the work at this bureau. Very close cooperation will be maintained with the more practical side of the problems as developed at the institute's laboratories.

The equipment at the institute includes, in addition to the research laboratory, a completely equipped model plant, and facilities for the instruction of a limited number of students.

GUAYULE RUBBER

The use of guayule in place of Hevea rubber would prove of great economic value to the United States, as the shrub from which it is produced can be successfully grown in Southwestern United States, California, and in Mexico. The results of a study recently made of this rubber are presented in Bureau of Standards Technologic Paper No. 353, entitled, "Some Vulcanization Tests of Guayule Rubber." This paper gives the results of some physical tests of guayule rubber grown in both Mexico and California. The samples of guayule rubber were obtained from shrub which had been harvested and treated, the rubber being forwarded to the Bureau of Standards. Figures are given showing the properties of different types of guayule rubber and several compounds made with standard plantation crêpes. Tests were made using "pure gum," zinc oxide, and gas-black formulas, and also in formulas where one-half the guayule rubber was replaced with plantation crêpe. Some data are given on the aging properties of compounds based on eight months' exposure to the weather protected from sunlight. The results indicate that properly prepared guayule rubber will compare favorably with plantation Hevea rubber.

Copies of this publication may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents each.

COPPER NUMBER OF PAPER

A Modified Method for Determination of the Copper Number of Paper is the title of Bureau of Standards Technologic Paper No. 354, recently issued. By the term "copper number," as applied to the examination of celluloses, is meant the amount of copper reduced from Fehling solution by a given amount of cellulose material. This determination is used to find the content of oxidation products and other degraded celluloses, the strength and durability of the cellulose material being adversely affected by such constituents. It is applied to paper to find its probable resistance to chemical deterioration and to study the effect on the paper fiber of the various chemical processes used in manufacturing the paper.

A modified method was developed especially for use in determining the copper number of high-grade, glue surface-sized, rag bond papers. Such papers are very tough and hard, and owing to their resistance to disintegration and to permeation by liquids, satisfactory analytical results are difficult to obtain by the usual procedure. The method is patterned after the method of Gault and Mukerji and that of Staud and Gray. The variation from these methods considered of prime importance is grinding the test specimens to a finely divided condition, this being found essential for obtaining uniform and accurate test results. Such procedure also is an advantage in that it reduces the time required for treatment of the paper in the various analytical manipulations. A grinder devised especially for treatment of paper is described in detail.

Copies of this paper may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents each.

LIGHT-COLORED FIRST-COAT ENAMELS FOR SHEET IRON

One of the features of the study of the development of light-colored first-coat enamels has been the development of a test for adhesiveness of the enamel to the metal. An item covering this appeared in Technical News Bulletin No. 122, June, 1927. The test which was described in that item has been further developed, and while there are certain sources of error introduced for the test pieces having a high breaking strength, it is believed that the test will serve the purposes of this work satisfactorily. Variations in the cooling treatment of the test specimens have been tried, including gradual cooling in a furnace, cooling in kieselguhr, and in air. The differences in strength caused by these variations is neither as marked nor as consistent as might be expected, but the slow cooling in the furnace was selected as to one leading most consistently to maximum strength.

As an illustration of the effect of firing treatment upon adhesiveness, the following work was carried out. A composition similar to a standard cobalt ground coat, except that the cobalt, manganese, and nickel oxides were omitted, has been applied over test pieces prepared in various ways. The following table indicates the treatments given the iron, the average breaking strength for each treatment, and the per cent of failure which occurred in the iron-enamel bond. The remainder of the failures occurred in the enamel itself.

Treatment of iron	Breaking strength	Failure in bond
	Pounds	*Per cent*
Ordinary treatment	400	100
Thin coating of iron oxide caused by heating the metal	434	98
Thin coating of cobalt oxide powder rubbed on metal	514	3
Metal dipped in 2 per cent suspension of cobalt oxide in water	662	45
Metal dipped in 2 per cent solution of nickel ammonium sulphate	684	90
Metal dipped in 2 per cent solution of cobalt chloride	632	85
Metal dipped in 2 per cent solution of cobalt ammonium sulphate	464	87
Metal dipped in 2 per cent solution of cobalt sulphate	590	87

These data are to be considered merely as indications of the relative results which may be expected under stated conditions. It is apparent from them that treatment of the iron before application of the enamel offers promising possibilities, and is a field worthy of further investigation. In the case of the treatment with cobalt oxide suspension the percentage of failure in the bond was noticeably decreased. However, the enamel appeared to be somewhat weakened by the latter treatment, which would, therefore, require modification before regular use.

STUDY OF GLASS TANK BLOCK

A test, forming the ninth and last of a series on glass-tank blocks, included in an investigation on glass-tank block corrosion, has recently been completed. The test consisted of melting 400 pounds of glass per day for 30 days at an average temperature of 1,400° C. The last tank contained clay blocks furnished by two manufacturers, and so-called special refractories as andalusite, mullite, and sillimanite were furnished by four manufacturers.

The porosity and relative pore size, which were determined on cylindrical specimens approximately 2 inches in diameter and 3 inches high, are as follows:

Block	Porosity	Pore size [1]		
		Large, after 20 minutes	Medium, after 72 hours	Small, after boiling
	Per cent	*Per cent*	*Per cent*	*Per cent*
A	28	90	3	7
B	30	88	2	10
C	26	91	4	5
D	22	90	2	8
E	[2]			
F	[2]			
G	10	92	2	6

[1] The pore size was determined from the rates of absorption of water after 20 minutes, 72 hours, and boiling.
[2] Negligible.

A preliminary petrographic examination of the various blocks gave the following information as to their composition:

A (clay block). Largely small, poorly developed mullite, with interstitial glass.

B. Largely corundum and andalusite, with smaller amounts of mullite and quartz and a little glass.

C. Largely very minute crystals of mullite in glass, with remnants of undissociated cyanite grains at their centers.

D (clay block). Largely minute crystals of mullite embedded in considerable glass, with indications that much solution of the quartz grains has taken place.

E and F. Mainly corundum with some glass, and with some minute needles of mullite in the latter.

G. Largely coarse grains of corundum and mullite with interstitial glass.

Blocks E and F showed the least amount of corrosion, with blocks B and G not materially more affected. However, blocks G and E cracked some time after installation. Block F was received partially cracked, and this crack continued through the entire block sometime during the test. Of the special refractories, block C showed the greatest amount of corrosion. The surface of this block exposed to the glass was badly pitted and had a spongy appearance. The two clay blocks compared favorably with the best of this type previously tested in resistance to the corrosive action of the molten glass. Blocks A, C, and D may have shown less resistance to attack because of poorly developed mullite crystals and a larger proportion of interstitial glass in combination with a relatively high porosity. The physical structure of the blocks, prepared from special refractory material, appears also to have a direct relation to their resistance to corrosion by the molten glass.

PHYSICAL PROPERTIES OF COMMERCIAL ENGLISH CHINA CLAYS

At the Columbus branch of the Bureau of Standards, work on the china-clay investigation during the past few months has included the evaluation of properties at high temperatures. Specimens of the 17 English clays being studied were fired to cones 18 and 23 (1,490° and 1,590° C.) and the softening points were obtained in the standard manner through a study of cone deformations. A summary of the results of this work may be of interest and is presented herein.

The specimens were the standard size bars used for such determination. A schedule of 24 to 30 hours was used in making the burn. An average of five tests was taken to obtain figures for all properties, with the exception of the modulus of rupture, where the figure was taken from 10 tests. The variation from one clay to another is so slight (less than 8 per cent on the average) that it seems justifiable for the present purposes to average all 17 clays for each property at each firing temperature, and upon this basis the following table is obtained:

Cone	3	5	8	11	14	18	23
Volume shrinkage.....per cent	20.0	26.3	32.5	41.7	48.8	48.5	48.5
Porosity.....do	40.29	35.92	28.96	17.49	3.85	1.22	1.01
Bulk specific gravity	1.60	1.75	1.91	2.17	2.45	2.50	2.50
Modulus of rupture	-------	-------	2,219	2,988	4,181	5,512	6,146

As would be expected, when the temperature of firing increases, the percentage volume shrinkage increases, the per cent porosity decreases, the bulk specific gravity increases, and the modulus of rupture increases.

The softening point determinations were made in a small surface combustion furnace at a rate of heating of 150° C. per hour above cone 20, which is the rate used by the bureau. The clays showed remarkable similarity in this

property, none of them softening below cone 33 and none above cone 35. The average is about cone 34, which corresponds to a temperature of 1,740° C. or 3,164° F.

UNITED STATES GOVERNMENT SPECIFICATION FOR SAND-LIME BRICK

A specification for sand-lime brick based upon data developed at the bureau has been promulgated by the Federal Specifications Board and published as Circular No. 347 of the Bureau of Standards.

The specification classifies sand-lime brick into three grades, namely, hard, medium, and soft, according to their absorption and transverse strength. The absorption is determined from the results obtained on immersion of the sample in water, after which the water is brought to a boil and the boiling continued for five hours. The transverse strength requirement is based upon the breaking load with a 7-inch span.

The specific values to be used in classifying sand-lime brick are indicated in the following table:

Class	Absorption		Transverse breaking load	
	Average of five	Individual maximum	Average of five	Individual minimum
	Per cent	*Per cent*	*Pounds*	*Pounds*
Hard	12 or less	15	1,080 or more	725
Medium	12 to 20	24	810 or more	540
Soft	20 or more	No limit	540 or more	360

The size of sand-lime brick acceptable under the specification shall be 2¼ by 3¾ by 8 inches with permissible variations of ⅛ inch in breadth or depth and ¼ inch in length. Not more than 5 per cent of the bricks delivered shall be broken, and at the completion of the absorption test the bricks comprising the sample shall show no evidence of a tendency to disintegrate.

Copies of the specification may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents each.

COMPARATIVE TESTS ON CONCRETE CYLINDERS OF DIFFERENT SIZES

A series of 216 concrete cylinders, mixed and made in the field, half of which were 8 by 16 inches and the remainder 10 by 20 inches, were recently tested at the bureau. The object of the series was the determination of the comparative strengths developed by the two sizes of specimens, using local sand and gravel under field laboratory conditions.

The cylinders were made in a small field laboratory, the concrete being mixed in a small batch mixer. Each batch was large enough to make four 8 by 16 and four 10 by 20 inch cylinders. After mixing to the desired consistency, the batch was emptied into a wheelbarrow and a shovel full was placed into each of the paper cylinder molds in succession until filled. Each cylinder was properly tamped during filling.

Three mixes were used, 1:1:2, 1:1½:3, and 1:2:4. The 1:1½:3 and 1:2:4 were tested at 3, 7, and 28 days. The 1:1:2 mix was tested at 3 and 28 days. For each proportion the concrete was mixed to three consistencies giving the approximate slumps of 2, 4½, and 6½. Since the cylinders in each group have the same amount of cement, water, aggregate, and mixing time the strength ratio of the 10 by 20 and 8 by 16 should be unaffected by many of the variables which enter cylinder making when duplications of mixes are attempted.

The average strength of the 10 by 20 inch cylinders was 96 per cent of the average strength of the 8 by 16 inch cylinders. The strength ratios were 92, 98, and 96 per cent, respectively, for the 1:1:2, 1:1½:3, and 1:2:4, respectively.

In connection with the testing of cylinders of several sizes, it is important to note that if tested in one machine at the same platten speed the increase in strain will be slower for the small specimens, a phenomenon observed and noted in the test of mine stoppings[1] and by Prof. D. A. Abrams.[2] The strength ratios were opposite to what might be expected because of this effect.

STUDY OF THE FACTORS GOVERNING THE STRENGTH OF CONCRETE

The bureau has completed a study of the variables entering into the fabrication of concrete, in which 3,000 cylinders were prepared and tested. Some tentative conclusions from these tests have already been reported in the November, 1926, Technical News Bulletin under the title "Water-cement ratio in concrete."

The variables studied are as follows:

1. Quality of cement. Four brands of Portland cement with different characteristics were used.

2. Gradation of the coarse aggregate. Eighteen gradings were studied.

3. Ratio of fine to coarse aggregate, four ratios being used.

4. Types of aggregates: Gravel, slag, and crushed limestone.

5. Age. The specimens were tested at six ages, namely, 1, 3, 7, and 28 days, and 3 and 12 months.

6. Proportions of mix. 1:1½:3, 1:2:4, 1:3:6 mixes were used in most part.

The specimens were removed from the molds at 24 hours and then placed in damp storage until test. All concrete was made of such consistency as to develop a flow of 95 as measured by the flow table, using 15 one-eighth-inch drops. The following conclusions may be drawn from the results of the tests:

1. At the ages of 1, 3, 7, and 28 days the variations in quality of the cement produced marked differences in the strengths of the 1:2:4 concrete. At the 3-month age, however, the difference in strengths was 9 per cent in term of the strength of the lowest one, and there was about 6 per cent at the age of 1 year.

2. The ratio of the strength of the concrete made from the four cements at 28 days varied from 1.96 to 2.76 of the strength at 7 days, under the conditions affecting this series of tests.

3. The proper ratio of fine to coarse aggregate for maximum strength depended on the type of the aggregate and its grading.

4. In most cases, when the coarse aggregate was deficient in one or two of the smaller sizes, that is, those varying between No. 4 to ⅜ inch and ⅜ to ¾ inch, a markedly better workability, together with very little change in strength, was obtained when using a mix in which the fine aggregate was 50 per cent of the total aggregate than when the fine aggregate was less than 33⅓ per cent of the total aggregate.

[1] Technical News Bulletin No. 118.
[2] Eng. and Cem. World, Jan. 15, 1918.

SIMPLIFICATION OF RAILROAD STATIONERY

An investigation recently concluded by a special committee of nine department heads of a large western railroad has resulted in a $55,000 reduction in that railroad's expenditures for stationery. The committee, which carried on its investigation for 18 months, examined 3,689 forms of stationery; of these forms, 379 were found to be obsolete or out of use, 651 were consolidated, and 1,980 were revised, leaving only 679 forms which were not altered. Savings were made by standardizing sizes, reducing varieties, and cheapening the quality of the paper stock where possible. Cost of the investigation and changes made was $4,689.

SIMPLIFICATION OF STEEL BARRELS AND DRUMS

It is interesting to note that the survey of the results of simplified practice in the steel barrel and drum industry for the year 1926 shows 89.04 per cent adherence to simplified practice recommendation. Only 10.96 per cent of the steel barrels and drums marketed during the year were nonstandard.

SIMPLIFICATION IN CONSULAR SERVICE

Representatives of 21 nations, members of the Pan American commission on the simplification and standardization of consular procedure, assembled in Washington, D. C., on October 10, for the purpose of working out a plan on this subject for the American Republics. The conference considered the reduction of the number of shipping documents requiring consular certification, simplification of data required for consular invoices, possibility of the adoption of a standard form of consular invoice, and a moderation of consular fees, and other questions relating to consular documentation, practice, and procedure.

BROADENING OF BUREAU'S SERVICES IN FIELD OF COMMERCIAL STANDARDS

The steadily increasing use of specifications as an aid in industrial and governmental buying is reflected in The National Directory of Commodity Specifications. In compiling this book, the bureau found more than 27,000 specifications covering 5,000 commodities. In the case of concrete reinforcing bars, there were 57 different specifications.

Since specifications apply mainly to grades and qualities, performance, and features other than size and dimension, it is evident that simplification, or the elimination of unnecessary sizes, is only a partial step in the elimination of waste. Experience with simplified practice has demonstrated the possibilities in many fields for further achievements in waste reduction through the elimination of unnecessary specifications and the establishment as "commercial standards" of those most widely or generally used. Manufacturers have already pointed out to the Department of Commerce the opportunity and the need for its cooperation in securing the elimination of unnecessary grades and qualities in various lines of products. They find that "too many grades" often complicate production and distribution to the same extent as "too many sizes."

In recognition of the request for cooperative service in this phase of the simplification program, the Department of Commerce announces through the Bureau of Standards that it is now prepared to aid those industrial and commercial groups desiring to establish standards of grade and quality for their products or their purchases, or to secure relief in instances where the current variety in grades, qualities, and specifications is a burden on the producer, and a handicap to the purchaser.

The bureau's service in this direction includes a certificate and labeling plan wherein goods manufactured according to commercial standards approved by the bureau may be so labeled and certified to by the manufacturers. This affords a greater protection to the purchaser and at the same time strengthens the manufacturer's selling arguments.

Groups desiring further information on this broadened service of the bureau are invited to address R. M. Hudson, Assistant Director, Commercial Standards, Commerce Building, Pennsylvania Avenue and Nineteenth Street, Washington, D. C.

NEW PUBLICATIONS

Additions to Supplementary List of Publications of the Bureau of Standards (beginning July 1, 1926)

Scientific Papers[1]

S558. An analysis of the arc and spark spectra of scandium (ScI and ScII); H. N. Russell and W. F. Meggers. Price, 20 cents.

S559. A burette for the accurate measurement of gas volumes without gas connection to a compensator; E. R. Weaver and M. Shepherd. Price, 5 cents.

S560. Density and electrical properties of the system, rubber-sulphur. Part I. Density of rubber-sulphur compounds; A. T. McPherson. Part II. Electrical properties of rubber-sulphur compounds; H. L. Curtis, A. T. McPherson, and A. H. Scott. Price, 15 cents.

[1] See footnote on p. 15.

S561. Cooperative measurements of radio fading in 1925; J. H. Dellinger, C. B. Joliffe, and T. Parkinson. Price, 15 cents.

Technologic Papers[1]

T350. A study of problems relating to the maintenance of interior marble; D. W. Kessler. Price, 35 cents.

T353. Some vulcanization tests of guayule rubber; D. Spence and C. E. Boone. Price, 5 cents.

T354. A modified method for determination of the copper number of paper; B. W. Scribner and W. R. Brode. Price, 5 cents.

Circulars[1]

United States Government Master Specifications for:

C338. Bag leather. Price, 5 cents.

C347. Common, sand-lime brick. Price, 5 cents.

C348. Light, short, rubber boots. Price, 5 cents.

C349. Hip, rubber boots. Price, 5 cents.

C350. Heavy, short, rubber boots. 5 cents.

Handbooks[1]

H11. Weights and measures administration; R. W. Smith. Price, 70 cents.

Technical News Bulletin[1]

TNB127. Technical News Bulletin, November, 1927.

OUTSIDE PUBLICATIONS[2]

Eye-protective glass. W. W. Coblentz; United State Patent Office (Washington, D. C.), Patent No. 1637439, dedicated to the Government and people of the United States; Patented August 2, 1927.

A study of types of goggles and their uses. Harold S. Norton; National Safety News (Chicago, Ill.), Vol. XVI, No. 4, p. 73; October, 1927.

Note on the relative comfort in reading by artificial daylight and unmodified gas-filled tungsten lamps. Irwin G. Priest; Journal, Optical Society of America and Review of Scientific Instruments (Ithaca, N. Y.), Vol. 15, No. 3, p. 131; September, 1927.

Ergebnisse der bisherigen temperaturmessungen des planeten Mars. W. W. Coblentz; die Naturwissenschaften (Berlin, Germany), Vol. 40, p. 809; October 7, 1927.

Pyrex as a container for radium solution. L. F. Curtiss; Nature (Edinburgh, Scotland); September 17, 1927.

The electrical resistivity of insulating materials. H. L. Crutis; Journal, American Institute of Electrical Engineers (New York, N. Y.), Vol. 46, p. 1095; October, 1927.

Formulas for calculation of the capacity of antennas. F. W. Grover; Proceedings, Institute of Radio Engineers (New York, N. Y.), Vol. 15, p. 733; August, 1927.

Electroplating. William Blum; Published in symposium "Chemistry's Contribution to Automotive Transportation"; Industrial and Engineering Chemistry (Washington, D. C.), Vol. 19, No. 10, p. 1111; October, 1927.

Nonferrous melting in electric furnaces. H. W. Gillett; Foundry (Cleveland, Ohio), Vol. 52, p. 805; 1927.

Development of electric brass melting in the United States. H. W. Gillett; Chemical Age (New York, N. Y.), Vol. 17, No. 423, p. 9; August 6, 1927.

Wear testing of metals. H. J. French; Engineering (London, England), Vol. 124, p. 279; 1927.

Measurement and application of certain physical properties of dental amalgams. Wilmer Souder; Journal of Dental Research (New York, N. Y.), Vol. VII, No. 2, p. 173; June, 1927.

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[1] Send orders for publications under this heading, with remittance, only to Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States, Canada, and Mexico); 40 cents (foreign).

[2] "Outside publications" are not for distribution or sale by the Government. Requests should be sent direct to publishers.

The significance of the elasticity and thermal expansion of fire clays with reference to the spalling of the fired product. R. F. Geller; Technologic Paper No. 4 of the American Refractories Institute (Pittsburgh, Pa.); October, 1927.

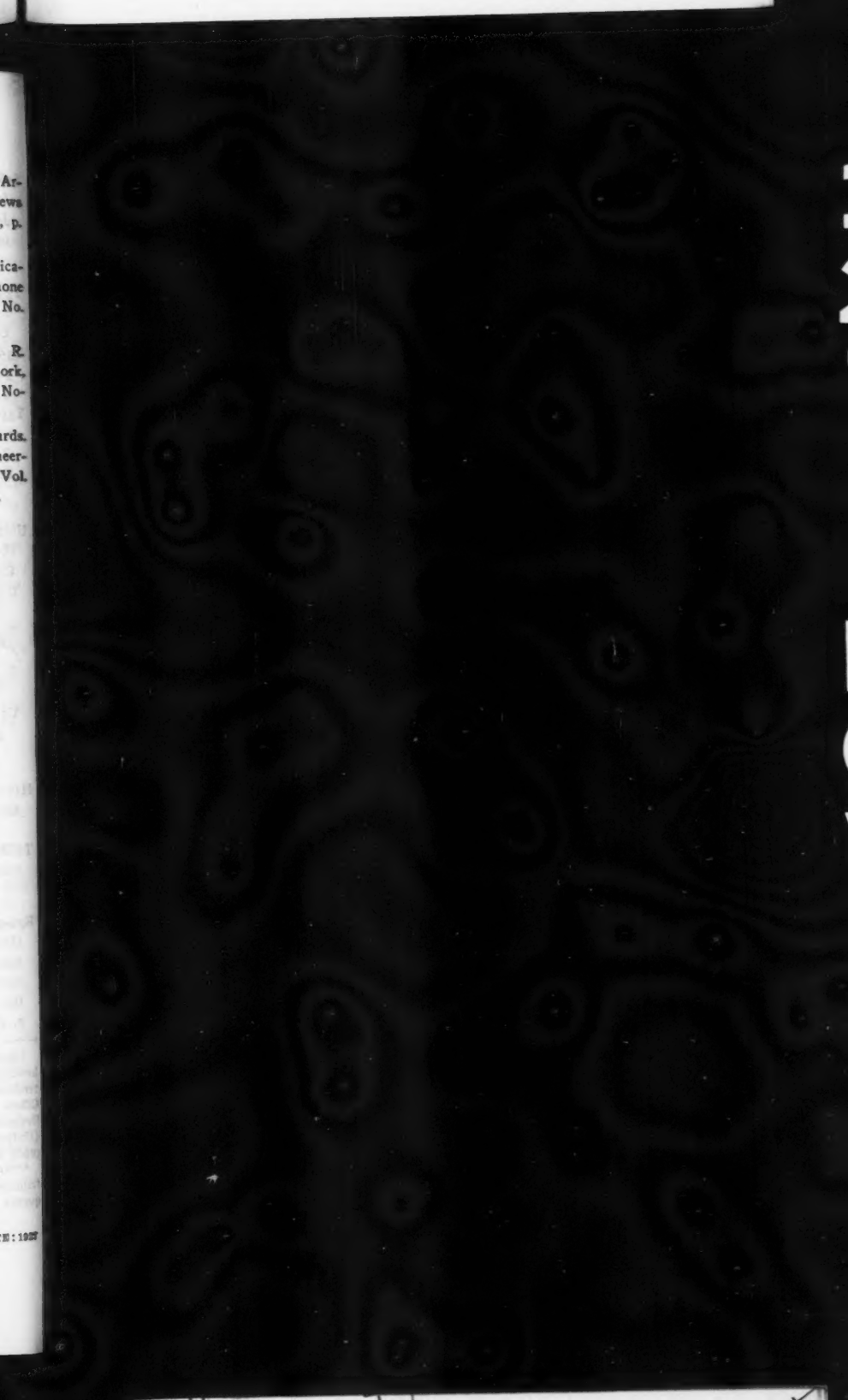
Composition of commercial chemical limes. J. S. Rogers; Industrial and Engineering Chemistry (Washington, D. C.), Vol. 19, No. 10, p. 1157; October, 1927.

Endurance tests of rope of different grades of abaca. F. A. Johnson and W. J. Stephenson; Cord Age (New York, N. Y.), Vol. XI, No. 4, p. 18; October, 1927.

Aviation develops safety standards. Arthur Halsted; National Safety News (Chicago, Ill.), Vol. XVI, No. 4, p. 49; October, 1927.

How safety code applies to communication lines. Arthur Halsted; Telephone Engineer (Chicago, Ill.), Vol. 31, No. 10, p. 23; October, 1927.

Muscles built the pyramids. Paul R. Heyl; Scientific American (New York, N. Y.), Vol. 137, No. 5, p. 396; November, 1927.

The National Bureau of Standards. George K. Burgess; Tech Engineering News (Cambridge, Mass.), Vol. VIII, No. 5, p. 209; October, 1927.

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